

EXHIBIT

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CURRICULUM VITAE

FRED S. APPLE, Ph.D, DABCC, FACSM

VITAL STATISTICS

1. Date of Birth: June 1953, Troy, New York

2. Present Address:

Work:

Clinical Laboratories, P4
Hennepin County Medical Center
701 Park Avenue
Minneapolis, MN 55415
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EDUCATION

1. 1975, B.S., Rensselaer Polytechnic Institute, Biology, advisors: KT Potts, Ph.D and L Cleseri, Ph.D.
2. 1979, Ph.D., University of Minnesota, Chemistry, advisors: RF Borch, Ph.D., M.D. and CF Moldow, M.D. Thesis: "Manipulation of the fatty acid composition of mammalian plasma membranes in culture".

POSTGRADUATE TRAINING

1. Clinical Chemistry Postdoctoral Fellow, Washington University School of Medicine, Barnes Hospital, advisor: JH Ladenson, Ph.D., Division of Laboratory Medicine, July 1980 to June 1982.
2. Technical Consultant Fellow, University of Minnesota, advisor: RF Borch, Ph.D., M.D., Department of Chemistry, March to May 1980.

ACADEMIC - PROFESSIONAL POSITIONS HELD

1. Co-Medical Director, Clinical and Forensic Toxicology Laboratory, Hennepin Healthcare / Hennepin County Medical Center, 2019 to present (accredited: CLIA, CAP, CAP FUDT, Joint Commission).
2. Principal Investigator, Hennepin Healthcare Research Institute (HHRI) (formerly

Minneapolis Medical Research Foundation), CLIA Laboratory Director of Cardiac Biomarkers Trials Laboratory (CBTL), CLIA ID Number 24D2019908; 1982 - present.

3. Professor, University of Minnesota School of Medicine, Department of Laboratory Medicine and Pathology, July 1995 to present.
4. Forensic Toxicology Consultant, Hennepin County Medical Examiner's Office, 1982 to 2019.
5. Program Director, Clinical Chemistry COMACC Fellowship at Hennepin Healthcare / Hennepin County Medical Center, Department of Laboratory Medicine and Pathology, 2013 to 2018.
6. Program Co-Director, Clinical Chemistry COMACC Fellowship at Hennepin Healthcare / Hennepin County Medical Center, Department of Laboratory Medicine and Pathology, 2019 to present.
7. Consultant, Fred S. Apple PhD, LLC; Forensic & Clinical Toxicology & Chemistry, 1985 to present.
8. Medical Director of Clinical Laboratories, Hennepin County Medical Center, 1996 to 2018 (accredited: CLIA, CAP, CAP POCT, CAP FUDT, ABFT, Joint Commission).
9. Medical Director of Clinical Chemistry and Toxicology Laboratories, Hennepin County Medical Center, July 1982 to 2018 (Toxicology Lab: CAP FUDT and American Board of Forensic Toxicology (ABFT) accredited).
10. Medical Director Point of Care Testing, Hennepin County Medical Center, 1995 to 2018 (CAP accredited).
11. Medical Director, Whittier Clinic Laboratory of Hennepin County Medical Center, 2015 to 2018 (CLIA, COLA accredited lab).
12. Medical Director, Richfield Clinic Laboratory of Hennepin County Medical Center, 2003 to 2015 (COLA accredited lab).
13. Medical Director, Richfield Clinic Laboratory of Hennepin County Medical Center, 2003 to 2015 (CLIA, COLA accredited lab).
14. Professor, Department of Kinesiology, University of Minnesota, July 1995 to 2010.
15. Medical Director, HFA Clinical Laboratories, December 2001 to 2012.
16. Program Director, Clinical Chemistry COMACC Fellowship at University of

Minnesota School of Medicine, Department of Laboratory Medicine and Pathology, 1996 to 2012.

17. Medical Director, North Central (formerly Regional Kidney Disease Program) Renal Laboratory of Total Renal Care (Davita), November 1992 to 2001.
18. Associate Director, Department of Pathology Residency Program 1993 to 2000.
19. University of Minnesota Graduate School Faculty Member:
 - a) Clinical Laboratory Science 1985 to present;
 - b) School of Kinesiology and Leisure Studies, 1992 to 2010;
 - c) Microbiology, Immunology, and Cancer Biology (Molecular Pathobiology) 1995 to 2003
20. Associate Professor, Department of Kinesiology, University of Minnesota, 1992 - 1995.
21. Associate Professor U of Minnesota School of Medicine, Department of Laboratory Medicine and Pathology, July 1988 to June 1995.
22. Assistant Professor, University of Minnesota School of Medicine, Department of Laboratory Medicine and Pathology, July 1982 to June 1988.
23. Visiting Assistant Professor, Department of Chemistry, University of Wisconsin - River Falls, September to November 1979.

HONORS, AWARDS, FELLOWSHIPS

1. National Science Foundation Summer Fellowship in Chemistry, RPI, 1974.
2. National Chemical Honorary Society, PHI Lambda Upsilon, 1974.
3. NIH Research Training Grant, Washington University School of Medicine, 1980 to 1982.
4. Young Investigator Award, International Society for Clinical Enzymology, 1983.
5. Fellow, American College of Sports Medicine, FACSM, 1986.
6. Visiting Professor, Karolinska Institute, Physiology III, Stockholm Sweden, November 1989; Recipient of Swedish National Council for Sports Research Award.
7. Visiting Lecturer, Danish Society Clinical Chemistry, Copenhagen Denmark, September 1991.

8. AACC Outstanding Speaker Award, 1995, 1996, 1997, 1998, 2001, 2002, 2003, 2004, 2005, 2007, 2009, 2010, 2015, 2016, 2017.
9. 1997 Canadian Society of Clinical Chemists Traveling Lectureship.
10. Visiting Professor, Emory University School of Medicine, Department of Pathology and Laboratory Medicine; December 15, 2005.
11. Visiting Professor, Harvard University Brigham and Women's Hospital, Department of Pathology, February 17, 2006.
12. Teacher of the Year Award, Clinical Pathology Residents Program, Department of Laboratory Medicine and Pathology, University of Minnesota School of Medicine, 2006-2007.
13. Visiting Professor Lecturer, FDA Center for Drug Evaluation and Research (CDER), November 21, 2008.
14. AACC 2009 Outstanding Award for Selected Area of Research.
15. AACC 2011 Reiner Award of AACC Capital Section.
16. Visiting Professor, Northwestern University Medical School, Department of Pathology, February 6, 2012.
17. Visiting Professor, Chinese University of Hong Kong Medical School – Prince of Wales Hospital, April 9-13, 2012.
18. Visiting Professor, Mayo Clinic, Department of Laboratory Medicine and Pathology, April 10, 2014.
19. AACC 2018 Outstanding Contributions Through Service to the Profession of Clinical Chemistry.
20. Visiting Professor/Scientist, Universitat Autònoma, Hospital de Sant Pau Department of Laboratory Medicine Barcelona Spain, January - March 2019.
21. 2020 IFCC Distinguished Award for Contributions to Cardiovascular Diagnostics.
22. 2020 Canadian Society of Clinical Chemistry Award for Education Excellence.

CERTIFICATIONS

1. Diplomat, American Board of Clinical Chemistry, Clinical Chemistry, 1986, No.750.
2. Diplomat, American Board of Clinical Chemistry, Toxicology, 1988, No.59.

3. Board Eligible, American Board of Forensic Toxicology, 1988.

PROFESSIONAL SOCIETIES - AFFILIATIONS

1. American Chemical Society, since 1977
2. American Association for Clinical Chemistry, since 1980.
 - a. Associate Editor, Clinical Chemistry, 2001 to present.
 - b. Board of Editors, Clinical Chemistry, 1991 - 2000; Editorials Editor, 1996 - 2000.
 - c. Section Co-Editor, Questions and Answers, Journal of the IFCC- 1996-2002.
 - d. Board of Editors, Forensic Urine Drug Testing Newsletter, 1993-1995.
3. American College of Sports Medicine, since 1981; Fellow since 1986.
4. International Society of Clinical Enzymology, 1983.
5. American Academy of Forensic Sciences, since 1986, member.
6. Academy of Clinical Laboratory Physicians and Scientists, since 1991.
 - a. Executive Council Member-at-Large 1999-2002
 - b. President-Elect 2002-2003
 - c. President 2003-2004, Past President 2004-2005
7. National Committee for Clinical Laboratory Standards (NCCLS); Clinical Chemistry, 1991-1993.
8. American Board of Clinical Chemistry, Board of Directors, 1992-1998.
9. Society of Forensic Toxicology (SOFT), member since 2000.
10. IFCC, Committee Standardization Markers of Cardiac Damage, Member 1998-2003; Chair 2004-2009.
11. FDA Clinical Chemistry and Clinical Toxicology Devices Panel of the Medical Devices. Advisory Committee, Center for Devices and Radiological Health, 2004-2005.
12. Canadian Society of Clinical Chemists, since 2000.
13. Member, United States Anti-Doping Agency (USADA) Anti-Doping Review Board, 2003 to 2020.
14. Global Task Force for Universal Definition of Myocardial Infarction, member; 2004 to present.

15. Member Editorial Board – Clinical Proteomics, 2004 to 2007.
16. The Commission on Accreditation in Clinical Chemistry (COMACC), member Board of Directors, 2009 to 2011.
17. Institute of Medicine, Committee on Qualification of Biomarkers as Surrogate Endpoints of Chronic Disease, 2008- 2010.
18. IFCC, member 'Committee (previously Task Force) on Clinical Applications of Cardiac Biomarkers (TF-CB), 2011 to 2016; Chair, 2017- present.
19. NHLBI Working Group: Tools and Technologies for Cardiovascular Research and Point of Care, June 2012.
20. Steering Committee, British Heart Foundation funded study, HighSTEACS: High-sensitive Troponin in the Evaluation of patients with Acute Coronary Syndrome: a randomized controlled trial. 2011 to present.
21. American Heart Association, Basic Cardiovascular Sciences Council. 2015 to present.

POSTDOCTORAL / GRADUATE / UNDERGRADUATE STUDENTS

1. Marc A. Rogers, Ph.D., 1984, School of Kinesiology and Leisure Studies, University of Minnesota; currently at University of Maryland.
2. Johanna W. Lampe, R.D., M.S., 1985, Department of Nutrition, University of Minnesota; currently at University of Washington.
3. Carole Schneider, Ph.D., 1986, School of Kinesiology and Leisure Studies, University of Minnesota; Assistant Professor, University of Northern Colorado.
4. Peter G. Davis, Ph.D., 1987, School of Kinesiology and Leisure Studies, University of Minnesota; currently at United States Olympic Committee.
5. Chin-Cheng Hsieh, Ph.D., 1994, School of Kinesiology and Leisure Studies, University of Minnesota; currently at National Hsinchu Teacher's University, Taiwan.
6. Ellen Voss, MT (ASCP), M.S., Clinical Laboratory Science, 1994, University of Minnesota. currently at St Jude Medical.
7. Judy Willoughby, Ph.D., 1996, School of Kinesiology and Leisure Studies, University of Minnesota; currently at University of Wisconsin - Superior.
8. Chuong Hoang, 3rd/4th year medical student University of Minnesota; recipient of

American Heart Association research award; October 1995 - June 1996; May-June 1997.

9. Emily Volmer, Minnesota AHA Undergraduate Research Assistant, July - August 1996.
10. Amy Berg, Minnesota AHA Undergraduate Research Assistant, July - August 1997.
11. Sara Lauer, Minnesota AHA Undergraduate Research Assistant, July - August 1998.
12. Ying Jie Chen MD, PhD candidate University of Minnesota, School of Kinesiology and Leisure Studies, 1999; currently at University of Minnesota School of Medicine.
13. Vincent Ricchiuti, PhD, Postdoctoral Research Fellow. June 1996 to June 1997, Clinical Chemistry Postdoctoral Fellow, July 1997 - June 1999; currently at Harvard University.
14. Gerswhin K. Davis MD PhD, Clinical Chemistry Postdoctoral Fellow, July 1999 - June 2001;
15. Lindsay Cheimeluski, MN AHA Undergraduate Research Assistant, June-August 2000-3.
16. Ricardo Bardales, Washington University undergraduate, July – August 2001.
17. Ryan Sykora, MN AHA Undergraduate Research Assistant, June - August 2001.
18. Adrine Chung, MN AHA Undergraduate Research Assistant, June - August 2002.
19. Alex Samuel, MN AHA Undergraduate Research Assistant, June - August 2004.
20. Emily Allex, MN AHA Undergraduate Research Assistant, June - August 2006.
21. Kristen Luckenbill PhD JD, Clinical Chemistry Postdoctoral Fellow. July 2006 to June 2008.
22. Kalen Olson PhD, Clinical Chemistry Postdoctoral Fellow. Sept 2008 to Aug 2010.
23. Zack Ross, Undergraduate Research Assistant, Hamilton College, May –August 2012.
24. Sara Love PhD, Clinical Chemistry Postdoctoral Fellow. July 2013 to June 2015.

25. Kathryn Katzung MD, Medical Toxicology Fellow, December 2013.
26. Olaia Rodriguez Fraga PhD, Hospital Universiratio La Paz, Madrid Spain, April-July 2013.
27. Beret Amundson St Olaf Rockswold Scholar, June-August 2014.
28. Danny Alexander Mohama, St Olaf Rockswold Scholar, June-August 2015.
29. Jorge Díaz-Garzón Hospital Universiratio La Paz, Madrid Spain, May-August 2016.
30. Ryan Hatch, St Olaf Rockswold Scholar, June-August 2016.
31. Mitchel Moe, St Olaf Rockswold Scholar, June-August 2017.
32. Ian Gunsolus PhD, Clinical Chemistry Postdoctoral Fellow. July 2016 to June 2018. Assistant Professor, Medical College of Wisconsin.
33. Peter Cunniff, St Olaf Rockswold Scholar, June-August 2018.
34. Jazmin Sunderland, St Olaf Rockswold Scholar, June-August 2019.

RESEARCH Laboratory at MMRF

Cardiac Biomarkers Trials Lab (CBTL), CLIA ID number – 24D2019908

1. Cardiac Biomarkers Trial Laboratory (CBTL):
 - a. Applications of cardiac and vascular biomarkers/assays for detection/rule out of myocardial infarction, myocardial injury, ischemic & inflammatory injury, reperfusion, & risk stratification and outcomes assessment in ACS, heart failure and vascular diseases.
 - b. Cost effective utilization of cardiac biomarker testing in patients presenting to rule in/rule out myocardial infarction and heart failure.
 - c. Clinicialtrials.gov studies
 - a. Use of TROPonin In Acute coronary syndromes [UTROPIA] Trial NCT02060760)
 - b. COMparisoN of High-sensitivity Cardiac TRoponin I and T Assays' [CONTRAST] Trial (NCT03214029)
 - c. Safe Emergency Department discharGe Rate [SEIGE] NCT04772157
 - d. Use of High Sensitivity cArdiac Troponin in Ruling Out Emergency Patients with acutE Myocardial Injury and Infarction [SAFETY] NCT04280926
2. Biochemistry of Exercise & Myocardial and Skeletal Muscle Ischemia:
Dynamics of protein expression and mRNA alterations in human and animal

heart and skeletal muscle in response to exercise and muscle disuse & following acute and chronic ischemia.

3. Toxicology (HCMC):

Forensic/postmortem analysis and postmortem redistribution of drugs and ethanol in tissues, blood, vitreous humor; medical legal ethanol and drugs of abuse pharmacokinetics; ethyl glucuronide and ethyl sulfate testing.

RESEARCH REPORTS (peer-reviewed):

1. Potts KT, Dunlap WC, Apple FS. Photodimerization of some 1,2,4-triazo (4,3-a) quinoline and 1,2,4-triazolo (3,4-a) -isoquinoline derivatives. *Tetrahedron* 1977; 33: 1263-7.
2. Ladenson JH, Apple FS, Koch DD. Misleading hyponatremia due to hyperlipemia: a method dependent error. *Ann Intern Med* 1981; 95: 707-8.
3. Apple FS, Koch DD, Graves S, Ladenson JH. Relationship between direct potentiometry and flame photometric measurement of sodium in blood. *Clin Chem* 1982; 28: 1931-5.
4. Apple FS, Greenspan N, Dietzler DN. Elevation of creatine kinase BB in hospitalized patients: importance of distinguishing BB CK from MB CK. *Ann Clin Lab Sci* 1982; 12: 398-402.
5. Ladenson JH, Apple FS, Aguanno JJ, Koch DD. Sodium measurements in multiple myeloma: two techniques compared. *Clin Chem* 1982; 28: 2383-6.
6. Apple FS, McGue MK. Serum changes during marathon training. *Am J Clin Path* 1983;79:716-9.
7. Apple FS, Walker FC, Dietzler DN. Serum creatinine concentrations and the discrepancy between EMIT and GLC phenytoin levels. *Ann Clin Lab Sci* 1983; 13: 385 - 92.
8. Ladenson JH, Apple FS, Aguanno JJ, Koch DD. Natriumbestimmung bei multiplem myelom; ein vergleich zweier techniken. *G T Lab Med* 1983; 6: 176 - 81 (In German).
9. Apple FS, Rogers MA, Sherman WM, Ivy JL. Creatine kinase isoenzyme patterns in gastrocnemius muscle obtained from marathon runners. *Selected Topics in Clinical Enzymol* 1984; 2: 419 - 28.
10. Apple FS, Rogers MA, Sherman WM, Ivy JL. Comparison of elevated serum creatine kinase MB activities post marathon race and post myocardial infarction. *Clin Chim Acta* 1984; 138: 111 - 8.
11. Apple FS, Rogers MA, Sherman WM, Costill D, Hagerman F, Ivy JL. Profile of creatine kinase isoenzymes in skeletal muscles of marathon runners. *Clin Chem* 1984; 30:413 - 6.
12. Yasmineh WG, Lewis L, Apple FS. Chromatographic behavior of immunoglobulin - creatine kinase on DEAE - Sephadex A - 50. *Clin Chim Acta* 1984; 144: 29-37.
13. Apple FS, Rogers MA, Sherman WM, Casal DC, Ivy JL. Creatine kinase MB isoenzyme adaptations in stressed human skeletal muscle. *J Appl Physiol* 1985; 59: 149-53.
14. Coe JI, Apple FS. Variation in vitreous chemical values due to instrumentation. *J*

- Forens Sci 1985; 30: 828-35.
15. Rogers MA, Apple FS. Creatine kinase isoenzyme activities in men and women following a 42.2 Km race. *Med Sci Sports Exer* 1985; 17: 679-82.
16. Lampe JW, Slavin JL, Apple FS. Poor iron status of women runners training for a marathon. *Intl J Sports Med* 1986; 7: 111-4.
17. Apple FS, Rogers MA. Creatine kinase isoenzyme MM in skeletal muscle and plasma from marathon runners. *Clin Chem* 1986; 32: 41-4.
18. Apple FS, Bandt C, Prosch A, Erlandson G, Holmstrom V, Scholen J, Googins MK. Creatinine clearance: enzymatic vs Jaffe determinations of creatinine in plasma and urine. *Clin Chem* 1986; 32: 388-90.
19. Apple FS, Rogers MA. Skeletal muscle lactate dehydrogenase isozyme alterations in men and women runners. *J Appl Physiol* 1986; 61: 477-81.
20. Apple FS, Rogers MA. Mitochondrial creatine kinase activity alterations in skeletal muscle during long distance running. *J Appl Physiol* 1986; 61: 482-5.
21. Lampe JW, Slavin JL, Apple FS. Elevated serum ferritin concentrations in master runners after a marathon race. *Internat J Vit Nutr Res* 1986; 56: 395-8.
22. Lampe JW, Slavin JL, Apple FS. Effects of moderate iron supplementation on the iron status of runners with low ferritin levels. *Nut Report Intl* 1986; 34: 959-66.
23. Clarkson PM, Apple FS, Byrnes WC, McCormick KM, Triffletti P. Creatine kinase isoforms following isometric exercise. *Muscle and Nerve* 1987; 10: 41-4.
24. Apple FS, Rogers MA, Casal DC, Lewis L, Ivy JL, Lampe JW. Skeletal muscle creatine kinase MB alterations in women marathon runners. *Eur J Appl Physiol* 1987; 56: 49-52.
25. Apple FS, Sharkey SW, Werdick M, Elspenger J, Tillbury RT. Analysis of creatine kinase isoenzymes and isoforms in serum to detect reperfusion after acute myocardial infarction. *Clin Chem* 1987; 33: 507-11.
26. Schneider C, Stull GA, Apple FS. Kinetic characterization of human heart and skeletal muscle CK isoenzymes. *Enzyme* 1988; 39: 220-6.
27. Apple FS, Bandt CM. Liver and blood postmortem tricyclic antidepressant concentrations. *Am J Clin Path* 1989; 89: 794-6.
28. Apple FS, Hellsten Y, Clarkson PM. Early detection of skeletal muscle injury by assay of creatine kinase MM isoforms in serum after acute exercise. *Clin Chem* 1988; 34: 1102-4.
29. Apple FS, Rhodes MD. Enzymatic estimation of skeletal muscle damage by analysis of changes in serum creatine kinase. *J Appl Physiol* 1988; 65: 2598-2600.
30. Sharkey SW, Apple FS, Elspenger KJ, Tilsury RT, Miller S, Fjeldos K, Asinger RW. Early peak of creatine kinase - MB in acute myocardial infarction with a non-diagnostic electrocardiogram. *Am Heart J* 1988; 116:1207-11.
31. Apple F, Preese L, Bennett R, Fredrickson A. Clinical and analytical evaluation of two immunoassays for direct measurement of creatine kinase MB with monoclonal anti-CK-MB antibodies. *Clin Chem* 1988; 34: 2364-6.
32. Sharkey SW, Elspenger KJ, Murakami M, Apple FS. Canine myocardial creatine kinase isoenzyme response to coronary artery occlusion. *Am J Physiol* 1989; 256: H508-14.
33. Eastep SJ, Benson PJ, Preese LM, Apple FS. Factitiously high sodium activities on the Ektachem 400 owing to interferences by high gamma-globulin

- concentrations. Clin Chem 1989; 35: 333-4.
34. Apple FS, Abraham PA, Rosono TG, Halstenson CE. Assessment of renal function by inulin clearance: comparison with creatine clearance as determined by enzymatic methods. Clin Chem 1989; 35: 312-14.
35. Apple FS, Tesch PA. CK and LD isoenzymes in human single muscle fibers in athletes. J Appl Physiol 1989; 66: 2717-20.
36. Apple FS. Postmortem tricyclic antidepressant concentrations: assessing cause of death using parent drug to metabolite ratio. J Analyt Tox 1989; 13: 197-8.
37. Apple FS, Roe SJ. Cocaine-associated fetal death in utero. J Analyt Tox 1990; 14:259-60.
38. Apple FS, Preese LM, Riley L, Gerken KL, VanLente F. Clinical and financial impact of a rapid CK-MB specific immunoassay on the diagnosis of myocardial infarction. Arch Path Lab Med 1990; 114: 1017-1020.
39. Sjodin B, Westing YH, Apple FS. Formation of oxygen free radicals during exercise. Sports Med 1990; 10: 236-54.
40. Lampe JW, Slavin JL, Apple FS. Iron status in active women: the effect of running a marathon on bowel function & gastrointestinal blood loss. Int J Sport Med 1991;12:173-9.
41. Sharkey SW, Murakami MA, Smith S, Apple FS. Canine myocardial creatine kinase isoenzyme redistribution three weeks after coronary occlusion: biochemical and ultrastructural correlates. Circulation 1991; 84: 333-40.
42. Apple F, Benson, P, Preese L, Eastep S, Heiler G, Bilodeau L. Lipase and pancreatic amylase activities in tissues and in patients with hyperamylasemia. Am J Clin Path 1991; 96: 610-4.
43. Apple FS, Hyde JE, Ingersoll AM, Stone J, Theologides A. Geographic distribution of xanthine oxidase, free radical scavenger, creatine kinase and lactate dehydrogenase enzyme systems in rat heart and skeletal muscle. Am J Anat 1991; 192: 319-23.
44. Apple FS. Acute myocardial infarction and coronary reperfusion: serum cardiac markers for the 1990s. Am J Clin Path 1992; 97: 217-26.
45. Nosaka K, Clarkson PM, Apple FS. Time course of serum protein changes after strenuous exercise of the forearm flexors. J Lab Clin Med 1992; 119: 183-8.
46. Apple FS. The creatine kinase system in overtrained runners. Clin Physiol 1992; 12: 1-6.
47. Bilodeau L, Grotte DA, Preese LM, Apple FS. Glycerol interference in serum lipase assay falsely indicates pancreas injury. Gastroenterology 1992; 103: 1066-7.
48. Balla G, Jacob HS, Balla J, Rosenberg M, Nath K, Apple F, Eaton J, Vercellotti GM. Ferritin: a cytoprotective antioxidant strategem of endothelium. J Biol Chem 1992; 267: 18148-53.
49. Schneider CM, Rogers MA, Lampe JW, Rhodes MC, Apple, FS. Serum creatine kinase isoenzyme measurements in master male and female marathon runners. Sports Med Train Rehab 1992; 3: 237-242.
50. Adams JE, Bodor GS, Davila-Roman VG, Delmez JA, Apple FS, Ladenson JH, Jaffe AS. Cardiac troponin I: A marker with high specificity for cardiac injury. Circulation 1993; 88:101-6.
51. Wu AHB, Valdes R, Apple FS, Gornet T, Stone MA, Mayfield-Stokes S, Ingersoll-

- Stroibos AM, Wiler B. Cardiac troponin-T immunoassay for diagnosis of acute myocardial infarction. *Clin Chem* 1994; 40: 900-907.
52. Apple FS, Billadello JJ. Creatine Kinase M and B subunit mRNA levels in exercise trained rat skeletal muscle. *Life Sci* 1994; 55: 585-92.
53. Apple FS, Preese LM. Creatine kinase MB: detection of AMI and monitoring reperfusion. *J Clin Immunoassay* 1994; 17: 24-29.
54. Theologides A, Ingersoll-Stroubos AM, Apple FS. TNF - effect on oxygen free radical scavenging and generating enzymes in rat liver. *Biochem Mol Biol Internal* 1994; 33: 205-210.
55. Apple FS, Bilodeau L, Preese LM, Benson P. Clinical implementation of a rapid, automated assay for assessing fetal lung maturity. *J Reprod Med* 1994;39:883- 7.
56. Apple FS, Voss E, Lund L, Preese L, Berger CR, Henry TD. Cardiac troponin, CK-MB and myoglobin for early detection of acute myocardial infarction and monitor of reperfusion following thrombolytic therapy. *Clin Chim Acta* 1995; 237: 59-66.
57. Apple FS. Glycogen phosphorylase BB and other cardiac proteins: challenges to creatine kinase MB as the marker for detecting myocardial injury. *Clin Chem* 1995; 41: 13 - 5.
58. Voss EM, Sharkey SW, Gernert A, Murakami MA, Johnston RB, Hsieh CC, Apple FS. Human and canine cardiac troponin T and CK-MB distribution in normal and diseased myocardium: infarct sizing using serum profiles. *Arch Path Lab Med*, 1995; 119:799-806.
59. Apple FS, Sharkey SW, Henry TD. Early serum cardiac troponin I and T concentrations following successful thrombolysis for acute myocardial infarction. *Clin Chem* 1995; 41: 1197-8.
60. Bodor GS, Porterfield D, Voss E, Smith S, Apple FS. Cardiac troponin I is not expressed in fetal and adult human skeletal muscle tissue. *Clin Chem* 1995; 41: 1710 - 5.
61. Apple FS, Henry TD, Berger CR, Landt YV. Early monitoring of coronary reperfusion following thrombolytic therapy by measurement of cardiac troponin I, creatine kinase MB and myoglobin. *Am J Clin Path* 1996; 105: 6-10.
62. Apple FS, Wu AHB, Valdes R. Serum cardiac troponin T concentrations in hospitalized patients without acute myocardial infarction. *Scand J Clin Lab Invest* 1996; 56: 63-8.
63. McLaurin M, Apple FS, Henry TD, Sharkey SW. Cardiac troponin I and T levels in patients with cocaine associated chest pain. *Ann Clin Biochem* 1996;33:183-6.
64. Hellsten Y, Apple FS, Sjodin B. The effect of sprint cycle training on activities of antioxidant enzymes in human skeletal muscle. *J Appl Physiol* 1996; 81: 1484-7.
65. Apple FS, Lowe MC, Googins MK, Kloss J. Serum thiocyanate concentrations in normal and renal impaired patients receiving nitroprusside. *Clin Chem* 1996; 42: 1878-9.
66. Tucker JF, Collins RA, Anderson AJ, Hauser J, Kalas J, Apple FS. Early diagnostic efficiency of cardiac troponin I and cardiac troponin T for acute myocardial infarction. *Acad Emerg Med* 1997; 4:13-21.
67. Apple FS, Sharkey SW, Hoeft P, Skeate R, Voss EM, Dahlmeier BA, Preese LM. Prognostic value of serum cardiac troponin I and T in chronic dialysis patients: a one year outcomes analysis. *Am J Kid Dis* 1997; 29: 399-403.

68. Bodor GS, Survant L, Voss EM, Smith S, Posterfield D, Apple FS. Cardiac troponin-T composition in normal and regenerating human skeletal muscle. *Clin Chem* 1997;43:476-84.
69. McLaurin MD, Apple FS, Voss EM, Herzog CA, Sharkey SW. Serum cardiac troponin I, cardiac troponin T, and CK MB in dialysis patients without ischemic heart disease: evidence of cardiac troponin T expression in skeletal muscle. *Clin Chem* 1997; 43: 976-82.
70. Ricchiuti V, Zhang J, Apple FS. Cardiac troponin I and T alterations in hearts with severe left ventricular remodeling. *Clin Chem* 1997; 43: 990-5.
71. Hoang CD, Zhang J, Payne RM, Apple FS. Post-infarction left ventricular remodeling induces changes in creatine kinase mRNA and protein subunit levels in porcine myocardium. *Am J Pathol* 1997; 151: 257-64.
72. Apple FS, Falahati A, Paulson PR, Miller E, Sharkey SW. Improved detection of minor ischemic myocardial injury with measurement of serum cardiac troponin I. *Clin Chem* 1997; 43: 2047-51.
73. Christenson RH, Apple FS, Morgan DL, Alonsozana GL, Mascotti K, Olson M, McCormack RT, Wians FH, Keffer JH, Duh SH. Cardiac troponin I measurement on the Access immunoassay system: analytical and clinical performance characteristics. *Clin Chem* 1997; 44: 52-60.
74. Apple FS, Sharkey SW, Falahati A, Murakami MA, Mitha N, Christenson D. Assessment of left ventricular function using serum cardiac troponin I measurements following myocardial infarction. *Clin Chim Acta* 1998; 272: 59-67.
75. Henderson AR, Gerhardt W, Apple FS. Summary with extrapolations of a roundtable on the use of biochemical markers in the diagnosis and theory of monitoring of patients with ischemic heart disease. *Clin Chim Acta* 1998; 272: 93-100.
76. Wu AHB, Feng YJ, Moore R, Apple FS, McPherson PH, Buechler KF, Bodor G. Characterization of cardiac troponin subunit release into serum after acute myocardial infarction and comparison of assays for troponin T and I. *Clin Chem* 1998; 44:1198-1208.
77. Ricchiuti V, Sharkey SW, Murakami MA, Voss EM, Apple FS. Cardiac troponin I and T alterations in dog hearts with myocardial infarction: correlation with infarct size. *Am J Clin Path* 1998; 110: 241-7.
78. McLaurin MD, Apple FS, Falahati A, Murakami MA, Miller EA, Sharkey SW. Cardiac troponin I and creatine kinase MB mass to rule out myocardial injury in hospitalized patients with renal insufficiency. *Am J Cardiol* 1998; 82: 973-5.
79. Ricchiuti V, Voss EM, Ney A, Odland M, Anderson PAW, Apple FS. Cardiac troponin T isoforms skeletal muscle of renal diseased patients will not cause false positive serum results by the second generation cardiac troponin T assay. *Eur Heart J* 1998; 19 (suppl N): N30-3.
80. Apple FS, Ricchiuti V, Voss EM, Ney A, Odland M, Anderson PAW. Expression of cardiac troponin T isoforms expressed in renal diseased skeletal muscle will not cause false positive results by the second generation cardiac troponin T assay by Boehringer Mannheim. *Clin Chem* 1998; 44: 1919-24.
81. Falahati A, Sharkey SW, Christensen D, McCoy M, Miller E, Murakami MA, Apple FS. Implementation of cardiac troponin I for detection of acute myocardial injury in

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